What is claimed is:

1. A method of fabricating a silicon-on-insulator structure having a silicon surface layer in a semiconductor workpiece, said method comprising:

placing said workpiece in a processing zone of a chamber bounded by a chamber side wall and a chamber ceiling facing said workpiece and between a pair of ports of said chamber near generally opposite sides of said processing zone and connected together by an external conduit of said chamber;

maintaining said workpiece at an elevated temperature;

introducing into said chamber a process gas comprising oxygen;

generating from said process gas a plasma current and causing said plasma current to oscillate in a circulatory reentrant path comprising said conduit and said processing zone.

2. The method of Claim 1 further comprising:

applying a bias to said workpiece and setting said bias to a level corresponding to an implant depth in said workpiece below said silicon surface layer to which oxygen atoms are to be implanted, whereby to form an oxygen-implanted layer in said workpiece having an oxygen concentration distribution generally centered at said implant depth.

3. The method of Claim 2 wherein the step of applying a bias to said workpiece comprises applying a pulsed D.C. bias voltage to said workpiece.

4. The method of Claim 1 wherein the step of generating a plasma current comprises coupling RF plasma source power into said conduit, whereby to cause said plasma current to oscillate at a frequency of said RF plasma source power.

5. The method of Claim 2 wherein said oxygen concentration distribution has a finite oxygen concentration in said silicon surface layer, said method further comprising:

reducing said oxygen concentration in said silicon surface layer.

6. The method of Claim 5 wherein the step of reducing said oxygen concentration in said silicon surface layer comprises:

enriching the silicon content of said silicon surface layer by implanting silicon atoms into said silicon surface layer and then heating said workpiece.

7. The method of Claim 5 wherein the step of reducing said oxygen concentration in said silicon surface layer comprises:

implanting an oxygen-getter species into said silicon surface layer and heating said workpiece.

8. The method of Claim 7 wherein said oxygen-getter species comprises hydrogen.

9. The method of Claim 5 wherein the step of reducing said oxygen concentration in said silicon surface layer comprises:

ion implanting a damage layer at or near said implant depth of said oxygen-implanted layer;

heating said wafer so as to cause the implanted oxygen in at least said silicon surface layer to migrate away from said silicon surface layer.

10. The method of Claim 9 wherein the step of ion implanting the deep damage layer is carried out by ion beam implantation of an atomic species to an implanted concentration less than that of said oxygen-implanted layer whereby to reduce the amount of time required to perform said ion beam implantation.

11. The method of Claim 10 wherein said atomic species comprises at least one of silicon, oxygen, hydrogen.

12. The method of Claim 10 wherein said implanted concentration of said deep damage layer is on the order of about $10^{15}$ cm-3.

13. The method of Claim 9 wherein the step of ion implanting the deep damage layer is carried out by plasma immersion ion implantation.

14. The method of Claim 13 wherein the step of plasma immersion ion implantation comprises:

placing said workpiece in a processing zone of a chamber bounded by a chamber side wall and a chamber ceiling facing said workpiece and between a pair of ports of said chamber near generally opposite sides of said processing zone and connected together by an external conduit of said chamber;

maintaining said workpiece at an elevated temperature;

introducing into said chamber a process gas comprising said atomic species;

generating from said process gas a plasma current and causing said plasma current to oscillate in a circulatory reentrant path comprising said conduit and said processing zone; and

applying a bias voltage on said workpiece corresponding to a deep implant depth below the implant depth of said oxygen-implanted layer.

15. The method of Claim 5 wherein the step of reducing said oxygen concentration in said silicon surface layer reduces said oxygen concentration below a threshold value under which epitaxial growth of a crystalline silicon layer on said silicon surface layer can be carried out.

16. The method of Claim 15 wherein said threshold value is about $10^{18}$ cm-3.

17. The method of Claim 15 further comprising:

depositing an epitaxial silicon layer on said silicon surface layer.

18. The method of Claim 5 wherein the step of reducing said oxygen concentration in said silicon surface layer comprises:

enriching the silicon content of said silicon surface layer by implanting silicon atoms into said silicon surface layer;

implanting an oxygen-getter species into said silicon surface layer;

ion implanting a damage layer at or near said implant depth of the implanted oxygen;

heating said wafer to a sufficient temperature and for a sufficient time to cause the implanted silicon to become substitutional in said silicon surface layer,, and implanted oxygen in or near said silicon surface layer to migrate away from said silicon surface layer.

19. The method of Claim 18 wherein said oxygen-getter species comprises hydrogen.

20. The method of Claim 18 wherein the step of reducing said oxygen concentration in said silicon surface layer reduces said oxygen concentration below a threshold value under which epitaxial growth of a crystalline silicon layer on said silicon surface layer can be carried out.

21. The method of Claim 20 wherein said threshold value is about $10^{18}$cm-3.

22. The method of Claim 5 wherein the step of reducing said oxygen concentration in said silicon surface layer comprises:

enriching the silicon content of said silicon surface layer by implanting silicon atoms into said silicon surface layer;

ion implanting a deep damage layer generally at said implant depth of the implanted oxygen;

heating said wafer so as to cause implanted oxygen in or near said silicon surface layer to migrate away from said silicon surface layer and the implanted silicon to become substitutional in said silicon surface layer.

23. The method of Claim 22 wherein the step of reducing said oxygen concentration in said silicon surface layer reduces said oxygen concentration below a threshold value under which epitaxial growth of a crystalline silicon layer on said silicon surface layer can be carried out.

24. The method of Claim 23 wherein said threshold value is about $10^{18}$ cm-3.

25. The method of Claim 1 wherein said process gas comprising oxygen comprises water vapor.

26. The method of Claim 1 further comprising:

immersing said workpiece in a plasma containing silicon ions while applying a bias voltage to said workpiece;

setting said bias voltage at a level such that silicon atoms are implanted in said silicon surface layer;

heating said workpiece.

27. The method of Claim 26 further comprising depositing an epitaxial layer of silicon on said silicon surface layer.

28. The method of Claim 26 wherein the step of depositing an epitaxial layer of silicon is performed before the step of heating the workpiece.

29. The method of Claim 26 wherein the step of depositing an epitaxial layer of silicon is performed after the step of heating the workpiece.

30. The method of Claim 27 wherein the step of depositing an epitaxial layer of silicon comprises setting said bias voltage to a level such that silicon atoms from said plasma accumulate on top of said silicon surface layer.

31. The method of Claim 27 wherein the step of depositing an epitaxial layer of silicon is performed contemporaneously with the step of implanting silicon in said silicon surface layer by setting said bias voltage to a level at which some silicon atoms from said plasma accumulate on top of said silicon surface layer while other silicon atoms from said plasma are implanted in said silicon surface layer.

32. The method of Claim 26 wherein said plasma further contains hydrogen ions, said method further comprising:

setting said bias voltage to a level at which hydrogen atoms are implanted in said silicon surface layer.

33. The method of Claim 26 wherein the step of immersing said workpiece in a plasma containing silicon ions comprises:

placing said workpiece in a processing zone of a chamber bounded by a chamber side wall and a chamber ceiling facing said workpiece and between a pair of ports of said chamber near generally opposite sides of said processing zone and connected together by an external conduit of said chamber;

maintaining said workpiece at an elevated temperature;

introducing into said chamber a process gas comprising silicon;

generating from said process gas a plasma current and causing said plasma current to oscillate in a circulatory reentrant path comprising said conduit and said processing zone.

34. A method of fabricating a silicon-on-insulator structure having a silicon surface layer in a semiconductor workpiece, said method comprising:

maintaining said workpiece at an elevated temperature;

producing an oxygen-containing plasma in said chamber;

applying a bias to said workpiece and setting said bias to a level corresponding to an implant depth in said workpiece below said silicon surface layer to which oxygen atoms are to be implanted, whereby to form an oxygen-implanted layer in said workpiece having an oxygen concentration distribution generally centered at said implant depth and having a finite oxygen concentration in said silicon surface layer;

reducing said oxygen concentration in said silicon surface layer.

35. The method of Claim 34 wherein the step of applying a bias to said workpiece comprises applying a pulsed D.C. bias voltage to said workpiece.

36. The method of Claim 34 wherein the step of reducing said oxygen concentration in said silicon surface layer comprises:

enriching the silicon content of said silicon surface layer by implanting silicon atoms into said silicon surface layer and then heating said workpiece.

37. The method of Claim 34 wherein the step of reducing said oxygen concentration in said silicon surface layer comprises:

implanting an oxygen-getter species into said silicon surface layer and then heating said workpiece.

38. The method of Claim 37 wherein said oxygen-getter species comprises hydrogen.

39. The method of Claim 34 wherein the step of reducing said oxygen concentration in said silicon surface layer comprises:

ion implanting a damage layer at or near said implant depth of the implanted oxygen;

heating said wafer so as to cause the implanted oxygen in at least said silicon surface layer to migrate away from said silicon surface layer.

40. The method of Claim 39 wherein the step of ion implanting the deep damage layer is carried out by ion beam implantation of one of oxygen, silicon, or hydrogen atoms to a reduced concentration less than that of said oxygen-implanted layer.

41. The method of Claim 40 wherein said reduced concentration is on the order of about $10^{18}$ cm-3.

42. The method of Claim 34 wherein the step of reducing said oxygen concentration in said silicon surface layer reduces said oxygen concentration below a threshold value below which epitaxial growth of a crystalline silicon layer on said silicon surface layer can be carried out.

43. The method of Claim 42 wherein said threshold value is about $10^{18}$ cm-3.

44. The method of Claim 42 further comprising:

depositing an epitaxial silicon layer on said silicon surface layer.

45. The method of Claim 34 wherein the step of reducing said oxygen concentration in said silicon surface layer comprises:

enriching the silicon content of said silicon surface layer by implanting silicon atoms into said silicon surface layer;

implanting an oxygen-getter species into said silicon surface layer;

ion implanting a damage layer at or near said implant depth of the implanted oxygen;

heating said wafer so as to cause implanted oxygen in or near said silicon surface layer to migrate away from said silicon surface layer , and the implanted silicon to become substitutional in said silicon surface layer .

46. The method of Claim 45 wherein said oxygen-getter species comprises hydrogen.

47. The method of Claim 45 wherein the step of reducing said oxygen concentration in said silicon surface layer reduces said oxygen concentration below a threshold value below which epitaxial growth of a crystalline silicon layer on said silicon surface layer can be carried out.

48. The method of Claim 47 wherein said threshold value is about $10^{18}$ cm-3.

49. The method of Claim 34 wherein the step of reducing said oxygen concentration in said silicon surface layer comprises:

enriching the silicon content of said silicon surface layer by implanting silicon atoms into said silicon surface layer;

ion implanting a damage layer at or near said implant depth of the implanted oxygen;

heating said wafer so as to cause implanted oxygen in or near said silicon surface layer to migrate away from said silicon surface layer and the implanted silicon to become substitutional in said silicon surface layer.

50. The method of Claim 49 wherein the step of reducing said oxygen concentration in said silicon surface layer reduces said oxygen concentration below a threshold value below which epitaxial growth of a crystalline silicon layer on said silicon surface layer can be carried out.

51. The method of Claim 50 wherein said threshold value is about $10^{18}$cm-3.

52. The method of Claim 34 further comprising:

immersing said workpiece in a plasma containing silicon ions while applying a bias voltage to said workpiece;

setting said bias voltage at a level such that silicon atoms are implanted in said silicon surface layer;

heating said workpiece.

53. The method of Claim 52 further comprising depositing an epitaxial layer of silicon on said silicon surface layer.

54. The method of Claim 53 wherein the step of depositing an epitaxial layer of silicon is performed before the step of heating the workpiece.

55. The method of Claim 53 wherein the step of depositing an epitaxial layer of silicon is performed after the step of heating the workpiece.

56. The method of Claim 53 wherein the step of depositing an epitaxial layer of silicon comprises setting said bias voltage to a level such that silicon atoms from said plasma accumulate on top of said silicon surface layer.

57. The method of Claim 53 wherein the step of depositing an epitaxial layer of silicon is carried out contemporaneously with the step of implanting silicon into said silicon surface layer, wherein said bias voltage is set to a level at which some silicon atoms from said plasma accumulate on top of said silicon surface layer while others of said silicon atoms are implanted in said silicon surface layer.

58. The method of Claim 52 wherein the step of immersing said workpiece in a plasma containing silicon and hydrogen comprises generating a plasma from a silane process gas in said reactor and causing said process gas to oscillate in said circulatory reentrant path.

59. The method of Claim 52 wherein said plasma further contains hydrogen, said method further comprising setting said bias voltage to a level at which hydrogen atoms from said plasma are implanted in said silicon surface layer.